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INSTRUCTION MANUAL

HIGH FREQUENCY PHASE JITTER

MEASUREMENT OPTION A3

(REF. MODEL 48A3)

HLI

HEKIMIAN LABORATORIES, INC.

15825 SHADY GROVE ROAD

ROCKVILLE, MARYLAND 20850 USA

INSTRUCTION MANUAL

HIGH FREQUENCY PHASE JITTER MEASUREMENT OPTION

MANUFACTURED BY

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SECTION 1.0
INTRODUCTION

1.1 GENERAL DESCRIPTION

The High Frequency Phase Jitter Measurement Option extends the capability of HLI Phase Jitter Meters to group frequency channels and above. With this option, all the parameters normally measured by the Phase Jitter Meter in the voice frequency channel may be made, at test signal frequencies between 4.0 kHz and 10 MHz.

This option consists of an internal frequency translator which may be operated at up to four fixed frequencies. The conversion process is used to heterodyne the selected test frequency down to the voice frequency operating range of the Phase Jitter Meter.

This option is available on all new Model 44A and Model 48 Phase Jitter Meters and may be retrofited to existing instruments. The option is completely self-contained and adds an additional input connector and input frequency selector switch (2 to 4 frequency positions) to the front panel of the Phase Jitter Meter. Power for this option is obtained from the unit's power supply.

In some cases this option may be used with more than four frequencies. Consult the factory with your requirements.

1.2 SPECIFICATIONS

The mechanical and electrical specifications for this option are contained in Table 1-1. The original specifications for the instrument are not changed.

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TABLE 1-1

SPECIFICATIONS

GENERAL

Frequency Range	4.0 kHz to 10.0 MHz
Operating Frequencies	Up to 4 fixed frequencies; switch selected.
Input Frequency Accuracy	Specified frequency ±10 Hz

INPUT

Level (Nominal)	-20 to +10 dBm
Impedance	75 ohm
Connector	
Operating Frequencies	
	A
	B
	C
	D
Crystal Frequencies	A 84.08 KHZ
	B 104.08 KHZ
	C ~~3.200 MHZ~~
	D 96.00

SECTION 2.0
INSTALLATION

2.1 GENERAL

This option is installed within the portable or rack mounted Phase Jitter Meter. To inspect the components and printed circuit board utilized in this option, the individual unit is opened in accordance with its instruction manual. Any damage due to shipping should be immediately reported to the shipping agency.

All internal adjustments on the option have been set at the factory, and no further adjustment is required prior to installation or use of the instrument.

2.2 PORTABLE UNIT INSTALLATION

On portable units, the high frequency input signal is connected to the front panel mounted INPUT connector associated with the INPUT selector switch. Various connectors are supplied to meet specific customer requirements. Shielded cable is recommended for all input signals.

2.3 RACK UNIT INSTALLATION

The high frequency input signal connector may be located on either the front or rear panel of the rack mounted units. Shielded cable should be used to connect the signal to the input barrier strip or mating connector.

SECTION 3.0

OPERATION

3.1 GENERAL

This section contains a description of the controls and indicators, operating procedures and methods of measurement to be used with this option. Prior to operation, be sure that all connections to the instrument are made in accordance with Section 2 of the Instruction Manual.

3.2 CONTROLS AND INDICATORS

The controls and indicators used with this option are described in Table 3-1. The INPUT selector switch is mounted on the front panel, while INPUT connectors may be mounted on either the front or rear panels. No internal adjustments are required during normal operation. Adjustment procedures for all internal controls are contained in Section 5.0, Maintenance.

TABLE 3-1

CONTROLS AND INDICATORS

Designation	Reference	Function
INPUT Connector	J1	Provides input connection for high frequency signals.
INPUT Selector Switch	S1	Selects VF operation or 1 of 4 HF test frequencies.

3.3 OPERATING PROCEDURES

This section presents the general operating procedures and the special considerations necessary when making group, carrier supply, and wideband measurements.

3.3.1 GENERAL

Operating frequency is selected using the INPUT selector switch S1. The test input signal should be within ±10 Hz of the specified test

frequency and is connected to the INPUT connector J1. Operating level ranges are specified in Table 1-1.

When the operating level covers the range of +2 to -20 dBm, the input level meter is calibrated to read directly in dBm referenced to the option input impedance. When the specified operating range is below -20 dBm, the input level meter is not calibrated, however, will generally give an on-scale reading with input test signals in the specified operating range.

The frequency scale may be used to verify that the input signal frequency is within the proper operating range of the Phase Jitter Meter. This scale cannot be used to measure input frequency.

All other functions of the Phase Jitter Meter remain unchanged from normal VF operation. In addition to the phase jitter, hit information may also be measured. All controls are adjusted in accordance with the operating procedures in the Phase Jitter Meter Instruction Manual.

3.3.2 GROUP CHANNEL MEASUREMENTS

Group channel measurements (typically 12 to 64 kHz) are made in an idle channel using a test signal from the distant end. Test signal level should be similar to the level used for normal tests or data transmission through the facility.

The test signal generator should be checked with a Phase Jitter Meter to ensure that it provides a jitter free output. Commercial generators typically have less than 1° p-p jitter at output frequencies below 10 kHz. At higher test frequencies, however, the generator may contribute more jitter than the channel under measurement.

Although measurements should be made in an idle channel, the design of this option minimizes measurement error due to spurious signals in the channel or direct signal feed-through.

3.3.3 CARRIER SUPPLY MEASUREMENTS

When equipped with the proper operating frequencies, this option may be used to directly measure phase jitter and hits on frequencies generated within the multiplex systems or on central office master carrier supplies. Test signals available from monitor jacks may be connected directly to the option INPUT connector. Both sine wave and square wave test signals can be used. The low residual reading (0.2° p-p or less) of the HLI instruments allows measurements of very low levels of phase jitter and this is particularly important at the lower frequencies used in the frequency generation portion of the multiplex equipment.

3.3.4 WIDEBAND MEASUREMENTS

Phase jitter measurements may be made directly on test carriers and pilots contained in the wideband (baseband) multiplex spectrum. When used in this manner, particular care must be taken to make sure that the test signal level (not the baseband composite level) is within the operating range specified in Table 1-1. In addition, the selected test carrier or pilot should not have any other pilots, residual carriers, or active voice channels within ±3 kHz of the measurement frequency or its harmonics. Undesired signals within these ranges may result in incorrect high readings.

When using the instrument for this purpose, it should first be established that satisfactory measurements can be made on a system known to be operating properly.

SECTION 4.0

THEORY OF OPERATION

4.1 GENERAL

This section provides a general theory of operation followed by detailed circuit operation on a functional block basis. This option provides an internal multiple fixed frequency translator which allows direct measurements to be made at group and carrier frequencies.

The input test signal is coupled to the input crystal controlled frequency translator. This translator hetrodynes the desired input frequency to the 1.0 kHz operating range of the phase jitter meter. Up to four different crystal controlled frequencies may be switch-selected for this translation. This translator is followed by a multi-section low pass filter to eliminate the translation oscillator carrier and an emitter-follower audio amplifier is used to isolate the output signal. The 1.0 kHz output signal is connected to the phase jitter meter through the INPUT selector switch.

The following sections describe in more detail the operation of this option. A detailed schematic diagram is contained in Figure 5-1 and a printed circuit board component location diagram is contained in Figure 5-2.

4.2 FREQUENCY TRANSLATOR

The signal from the INPUT connector is connected to a resistor network consisting of R17, R18 and R19. This network sets the level at the input to the mixer, IC6, and provides impedance matching to the input signal. It may be adjusted for either bridging or any single terminating impedance.

The input signal is then applied to IC6 which contains a double-balanced mixer in a single IC package. The oscillator circuits are crystal controlled using crystals Y1 to Y4 and IC1. Indivi-

dual frequency adjustments are made by the factory selected capacitors C1, C2, C3 thru C10, C11 and C12. The oscillators are controlled by the INPUT selector switch which connects +15 VDC to the desired oscillator. This oscillator signal is fed into a chain of frequency dividers IC3A-B and IC4A-B. The divided signal is then switched into the mixer by turning on the proper NAND gate IC5A-D. This translates the input signal down to the 1.0 kHz test frequency used by the Phase Jitter Meter.

The translator output is filtered by the two-section RC filter consisting of R30, R32 and C19, C20. The filter output drives the emitter-follower audio amplifier Q1. The output of this amplifier then feeds the Phase Jitter Meter when the INPUT switch is in the non-VF position.

4.3 SIGNAL SWITCHING

This option is controlled by the INPUT selector switch S601. During normal VF operation, the 1 kHz input terminals are connected directly to the Phase Jitter Meter's input circuitry. When another frequency is selected, the INPUT selector switch supplies +15 volts to the option and connects its audio output to the meter's VF input. The INPUT selector switch also selects the proper oscillator and division ratio.

The +15 volt power supply is obtained directly from the Phase Jitter Meter's power supply.

SECTION 5.0
MAINTENANCE AND CALIBRATION

5.1 MAINTENANCE PHILOSOPHY

Maintenance procedures for this option are divided into preventive and corrective classifications. Preventive maintenance consists of the routine performance checks which may be made using the front panel controls of the instrument. Corrective maintenance covers the symptom analysis, trouble shooting, repair, and recalibration of the option.

5.2 PREVENTIVE MAINTENANCE

5.2.1 GENERAL

The preventive maintenance procedures described in the following sections are used by the operator and the maintenance personnel to verify proper option operation using the front panel controls. If proper operation is not achieved, see Section 5.3 for corrective maintenance procedures.

Periodic cleaning, lubrication, or inspection of this option is not required.

All of the following checks are made using the instrument adjusted in accordance with Section 5 of its instruction manual. The group frequency test signal is supplied by an external signal generator whose exact frequency and level should be measured prior to these tests.

5.2.2 INPUT LEVEL CHECK

Place the INPUT selector switch in the desired frequency input position. Connect a test signal to the option input and monitor its level with an appropriate external meter and set the level to the nominal value given in Table 1-1 (page 1-2). Set the

Phase Jitter Meter meter switch to the INPUT LEVEL position and verify that the reading is 0 dBm ±0.5 dB. Be sure and make any necessary corrections in comparing the dBm reading (1 milliwatt across the characteristic input impedance) to the voltage or dB calibration on the external reference meter.

5.2.3 INPUT FREQUENCY CHECK

Place the meter switch in the FREQUENCY position and verify that an on-scale reading is obtained without a CAUTION indication.

5.3 CORRECTIVE MAINTENANCE

5.3.1 TROUBLE SHOOTING

This section covers symptom analysis, circuit level trouble shooting, and calibration procedures for this option. No specialized mechanical assembly or disassembly procedures are required. Standard practices should be followed when repair is undertaken on the front panel switch or the translator printed circuit board.

Recommended trouble shooting techniques are based on signal tracing methods, where a known input signal is used, and level and waveforms are verified as the signal progresses through the circuitry. Typical test equipment required to perform these trouble shooting procedures are listed in Table 5-1.

When using test signal frequencies above 50 kHz, an extremely stable or synthesized signal source is required.

TABLE 5-1

MAINTENANCE TEST EQUIPMENT

Description	Typical Model Number
Test signal generator	HP 204 C
AC voltmeter	HP 400 EL
Oscilloscope, 1 MHz frequency response	Tektronix 323

5.3.2 CIRCUIT LEVEL TROUBLE SHOOTING

The preventive maintenance checks of Section 5.2 are used to determine proper operation. When this is not obtained, the general procedures to be used in locating malfunctions are described in the following sections. Where appropriate, performance standards, levels, and waveform descriptions are provided to assist in the trouble shooting process. When a circuit has the proper input signal, but the correct output cannot be measured, the components associated with that circuit should be checked and replaced if defective. Failure in an integrated circuit may often be located by feeling the case temperature. Normally, integrated circuits are moderately warm to the touch; however, when defective, they can become extemely warm causing a painful sensation when touched.

5.3.2.1 INPUT

Before detailed trouble shooting is undertaken, the +15 volt power supply voltage should be checked at terminal I of the option board.

The presence of the input signal may be verified using the oscilloscope at the INPUT connector and at terminals F and G of the option printed circuit board. The input should also be verified between pins 1 and 4 of IC6. This signalwill be attenuated by the input network R17, R18 and R19 and will have a DC offset resulting from the bias voltages of IC6.

5.3.2.2 OSCILLATOR

Crystal oscillator performance is checked using an oscilloscope at pin 13 of IC2B. When operating properly a square wave of 12 volts peak-to-peak at the crystal oscillator frequency will be seen at this point.

5.3.2.3 DIVIDER

The frequency divider chain can be checked using an oscilloscope. When operating properly a square wave of 12 volts peak-to-peak at a frequency of 1010 Hz below the selected input frequency will be present at pin 1 of IC2A. Each divider in the chain is a divide by two.

5.3.2.4 MIXER AND AMPLIFIER

With the proper input frequency applied, verify with an oscilloscope that an output signal is seen at pin 6 of IC6. For a nominal input level of 0 dBm the output level will be a sine wave of approximately 0 dBm at a frequency of 1010 Hz ±10 Hz. There will also be some carrier feed-through seen at this point along with a DC voltage of approximately 10V due to the bias at pin 6 of IC6. The filtered output level may be observed at terminal J of the option board.

5.3.3 CALIBRATION

The following procedures are used to recalibrate the frequencies of the translation oscillators and the overall gain. Recalibration is normally required when maintenance has been performed on the associated circuitry or when there is reason to suspect the calibration is no longer accurate.

5.3.3.1 OSCILLATOR FREQUENCY

In many cases where the signal frequency is below 1 MHz and the divider ratio is high, the calibration tolerance of the crystal itself is sufficient to insure a proper mixing frequency. In those cases where the signal frequency is high or a low divider ratio is used a variable capacitor, C3, C6, C9 or C12 is used to trim oscillator frequency. This may be adjusted as follows. Use a frequency counter with a high input impedance low capacity probe to monitor the oscillator frequency at pin 13 of IC2B. Adjust trimmer capacitor, C3, C6, C9 or C12 to provide an oscillator frequency equal to the crystal frequency given in Table 1-1.

5.3.3.2 GAIN

Step A Connect a proper frequency input signal to the option INPUT and set its level to the nominal value of Table 1-1 (referenced to the option input impedance).

Step B Place the METER switch in the INPUT LEVEL position. and adjust R28 for a reading of 0 dBm.

5.3.4 CRYSTAL FREQUENCY

The crystal frequency is a function of the input frequency and the division ratio. Crystal frequencies in the range of 3.0 MHz to 10.0 MHz are generally used to provide good stability and low cost. The required crystal frequency is given by the following formula.

$$F_C = N(F_S + 1.01) \quad \text{or}$$
$$F_C = N(F_S - 1.01)$$

where F_C = Crystal Frequency
F_S = Input Frequency
N = Division Ratio

The division ratio is a power of two in the range of 1 to 1024 as shown in Table 5-2.

TABLE 5-2

DIVISION RATIO

Pin Number	Division Ratio	
	With IC3	Without IC3
11	1	1
10	2	-
9	4	1
5	8	2
6	16	4
7	32	8
8	64	16
4	128	32
3	256	64
2	512	128
1	1024	256

A division ratio of unity should only be used for input frequencies above 5.0 MHz. For crystal frequencies above 5.0 MHz with a division ratio other than unity, IC3 must be used.

TABLE 5-3 HIGH FREQUENCY PHASE JITTER MEASUREMENT OPTION PARTS LIST

Fig.No.	Ref. No.	Description	Part No.	Mfr.
5-2	C1, C2	Capacitor, Fixed, Dipped Mica, Factory Selected	DM-15	
	C3	Capacitor, Trimmer, Ceramic, 5-18pf, NPO	538-011A	Erie
	C4, C5	Same as C1		
	C6	" C3		
	C7, C8	" C1		
	C9	" C3		
	C10, C11	" C1		
	C12	" C3		
	C13 thru C17	Capacitor, Fixed, Ceramic Disk, .1 MFD, 20V, +80%, -20%	UK-20-104	Centralab
	C18, C19	Capacitor, Fixed, Ceramic Disk, 3900pf, 250V, 10%	255-D39	Sprague
	C20	Capacitor, Fixed, Dipped Mica, 620pf, 500V, 5%	DM-15	
	C21	Capacitor, Fixed, Tantalum, 22 MFD, 15V, 10%	CS13B	
	C22 thru C26	Capacitor, Fixed, Ceramic Disk, .01 MFD, 250V, 20%	511	Mial
	C27	Same as C13		
	IC1	Integrated Circuit, Quad Nand, MOS	MC14011CP	Motorola
	IC2	Integrated Circuit, Dual Nand, MOS	MC14012CL	"

Fig.No.	Ref. No.	Description	Part No.	Mfr.
5-2	IC3	Integrated Circuit, Factory Selected	MC14013CL	Motorola
	IC4	Integrated Circuit, Dual Divider, MOS	MC14520CP	"
	IC5	Same as IC1		
	IC6	Integrated Circuit, Balanced Mixer	MC1496L	Motorola
	J1	Input Connector, Factory Selected		
	Q1	Transistor, Silicon, NPN	2N4401	Motorola
	R1	Resistor, Fixed, 10MΩ, 1/4w, 5%	RCR07	A.B.
	R2	Resistor, Fixed, Factory Selected	RCR07	A.B.
	R3	Same as R1		
	R4	Same as R2		
	R5	Same as R1		
	R6	Same as R2		
	R7	Same as R1		
	R8	Same as R2		
	R9 thru R16	Resistor, Fixed, 100KΩ, 1/4w, 5%	RCR07	A.B.
	R17 thru R19	Resistor, Fixed, Factory Selected	RN55D	Corning

Fig.No.	Ref. No.	Description	Part No.	Mfr.
5-2	R20	Resistor, Fixed, 12KΩ, 1/4w, 5%	RCR07	A.B.
	R21	Resistor, Fixed, 1.62KΩ, 1/8w, 1%	RN55D	Corning
	R22	Resistor, Fixed, 1KΩ, 1/8w, 1%	"	"
	R23	Resistor, Fixed 866Ω, 1/8w, 1%	"	"
	R24 thru R26	Same as R22		
	R27	Resistor, Fixed, 100Ω, 1/8w, 1%	RN55D	Corning
	R28	Resistor, Variable, 500Ω, 1/4w, 10%	72PMR500	Helitrim
	R29	Resistor, Fixed, 13.7KΩ, 1/8w, 1%	RN55D	Corning
	R30, R31	Resistor, Fixed, 4.87KΩ, 1/8w, 1%	"	"
	R32	Resistor, Fixed, 24.3KΩ, 1/8w, 1%	"	"
	R33	Resistor, Fixed, 200Ω, 1/4w, 5%	RCR07	A.B.
	R34	Resistor, Fixed, 10KΩ, 1/4w, 5%	"	"
	S1	Switch, Rotary, 6 Position, 4 Pole	PSA-211	Centralab
	Y1 thru Y4	Crystal, Quartz, Factory Selected		

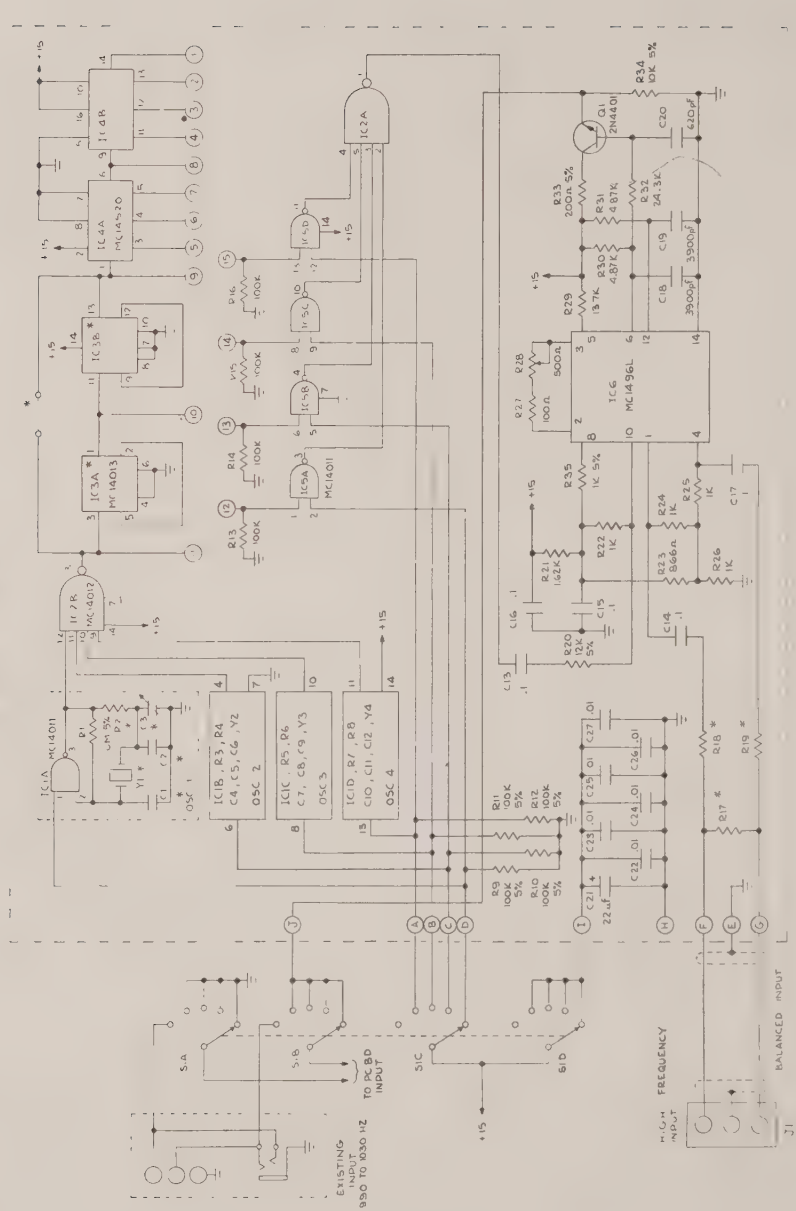

FIGURE 5-1 SCHEMATIC DIAGRAM FOR THE HIGH FREQUENCY PHASE JITTER MEASUREMENT OPTION

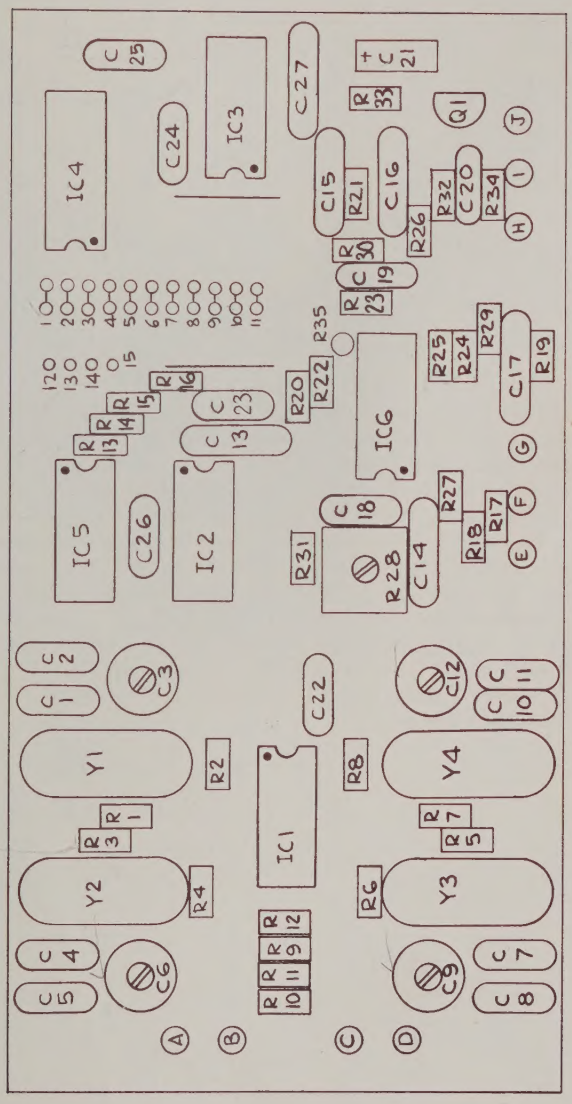

FIGURE 5-2 HIGH FREQUENCY PHASE JITTER MEASUREMENT OPTION
P.C. BOARD COMPONENT LAYOUT

WARRANTY

All Hekimian Laboratories, Inc., products are warranteed against defects in materials and workmanship for a period of one year from date of delivery. HLI will repair or replace at no cost, products which prove to be defective during the warranty period. Upon authorization by HLI, the equipment may be returned to the factory prepaid for repair. Upon completion of repair, the equipment will be returned at HLI expense. If, upon examination of the defective item, it is evident that failure was not due to defective workmanship or material, HLI will bill the purchaser for the cost of replacement or repair, including transportation charges. HLI does not warrant the merchantability of its products and does not make any warranty, expressed or implied, other than the warranty contained herein.

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